



The influence of cost on customer satisfaction in e-commerce logistics: Mediating roles of service quality, technology usage, transportation time, and production condition

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ABSTRACT

This study investigates the mediating roles of technology usage, service quality, transportation time, and product condition in the relationship between cost and customer satisfaction in the online retail logistics sector. Data were collected from 316 online sellers in Thailand, and the PROCESS macro was used to analyze both direct and indirect effects. The results demonstrate that cost significantly impacts customer satisfaction, with this effect being amplified by the mediating roles of technology usage and product condition. Technology usage emerged as the most influential mediator, highlighting its critical importance in enhancing customer experience. Product conditions also play a significant role, emphasizing the necessity of maintaining high standards in logistics operations. Conversely, the mediating effects of service quality and transportation time were less significant, indicating a potential context-dependent influence. This research fills a critical gap in understanding cost-customer satisfaction dynamics by incorporating open innovation frameworks and highlighting the pivotal roles of technology and product integrity in Thailand's rapidly evolving e-commerce logistics landscape. Beyond its relevance to Thailand's e-commerce logistics, the findings offer actionable insights applicable to other emerging markets globally. These include strategies to leverage technology and ensure product integrity, aligning with global trends in enhancing operational transparency and customer satisfaction.

1. Introduction

Cost plays a pivotal role in shaping customer satisfaction, especially in the highly competitive landscape of online retail. The relationship between cost and customer satisfaction is complex and multifaceted, with various mediating factors influencing this dynamic. The mediating effect model highlights that cost impacts customer satisfaction in non-linear ways, with several mediating effects playing a crucial role in shaping this relationship (Grewal et al., 2011; Monroe, 2022). In the context of online retail in Thailand, understanding these mediating factors is crucial for both researchers and practitioners. Despite extensive studies on customer satisfaction in logistics, most research has focused on individual factors without integrating these mediators in the context of emerging markets like Thailand. Recent research identifies

key factors influencing customer satisfaction in logistics, including service quality, delivery logistics, competitive pricing, and transportation time. Service quality is consistently recognized as the strongest predictor of satisfaction (Praba and Mashudi, 2024). Delivery logistics, including time, cost, and quality, remain critical to customer perceptions. However, their integration with advanced technologies such as AI-driven predictive analytics offers deeper insights into improving satisfaction levels while addressing cost constraints. In Thailand, service quality and transport time have been regarded as baseline expectations due to intense competition in the e-commerce market. Consumers expect standardized fast deliveries and seamless service as norms rather than distinguishing factors. Therefore, understanding their nuanced influence in Thailand's logistics sector is crucial for identifying differentiators like technology usage and product integrity that more directly

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elevate customer satisfaction (Kotler, Keller, Brady, Goodman, and Hansen, 2016; Umair, Zhang, Han, and Haq, 2019). Despite extensive research on customer satisfaction in logistics, prior studies often focus on developed markets or individual mediators without considering their interrelationships in emerging market contexts. For instance, research in Southeast Asia predominantly emphasizes delivery time and service quality as key factors yet lacks integration of technological innovation and product integrity as critical mediators. Thailand, as one of the fastest-growing e-commerce markets, presents unique challenges such as diverse infrastructure, varied consumer expectations, and rapid digital adoption. This study addresses these gaps by examining how cost influences customer satisfaction through a multi-mediator framework tailored to Thailand's evolving logistics landscape. Furthermore, by incorporating lessons from global trends in open innovation and digital technology, the findings contribute to broader applications in other emerging markets. Competitive pricing enhances satisfaction, especially in cost-sensitive segments, while shorter transportation times directly correlate with higher satisfaction levels (Umair et al., 2019). However, these mediators remain underexplored in Thailand's e-commerce sector, where unique consumer expectations and logistical challenges offer a rich area for investigation. Unlike previous research, this study focuses on Thailand's emerging market dynamics, emphasizing its diverse infrastructure and rapid digital innovation adoption. Specifically, it integrates contextual factors such as real-time tracking systems and AI-driven customer support into the analysis of cost-satisfaction relationships.

The growing e-commerce market in Thailand has intensified competition, making it imperative for online retailers to optimize their pricing strategies while maintaining high levels of customer satisfaction (Kotler et al., 2016). Thailand represents one of the fastest-growing e-commerce markets in Southeast Asia (TMO Group Asia, 2023), characterized by diverse market structures and unique consumer expectations, particularly regarding fast and transparent logistics services. For instance, platforms like Shopee and Lazada exemplify social open innovation by integrating customer feedback loops to refine logistics solutions (Gawer and Cusumano, 2014). These practices align with collective intelligence principles and underscore how open innovation frameworks can address logistical challenges in dynamic markets like Thailand. Thai consumers increasingly demand advanced logistics technologies such as real-time parcel tracking and AI-driven customer support. Globally, logistics technologies such as AI-driven routing, blockchain-based transparency mechanisms, and IoT-enabled monitoring have demonstrated their effectiveness in improving service quality and delivery performance (Cai, Yuen, Xie, Fang, and Wang, 2021). These insights provide valuable parallels for Thai e-commerce logistics, where infrastructure diversity requires adaptive technological solutions. These findings not only underscore the significance of technology in Thailand's logistics sector but also align with global trends in logistics innovation. For example, the adoption of blockchain technology for supply chain transparency and AI-driven predictive analytics has become pivotal in enhancing customer satisfaction across emerging and developed markets. This study, therefore, contributes to a broader understanding of how such technological advancements can be tailored to address unique regional challenges while providing scalable solutions applicable worldwide. Despite the significant interest in customer satisfaction and the recognized importance of cost in influencing consumer satisfaction within the logistics sector, there has been a lack of empirical research exploring the specific pathways or processes through which cost affects customer satisfaction in this field (Parasuraman, Zeithaml, and Berry, 1985). For instance, no research has yet examined how these factors mediate the relationship between cost and customer satisfaction within a market characterized by diverse infrastructure and rapid digital adoption. This study addresses these gaps by applying open innovation principles, emphasizing how bounded rationality in logistics decision-making and collective intelligence enhance operational strategies (Chesbrough, 2003). Despite significant advancements in

e-commerce research globally, there remains limited understanding of how specific mediating factors, such as technology and product condition, influence the cost-satisfaction dynamic in Thailand's rapidly evolving e-commerce landscape. This research seeks to address this gap by contextualizing findings within Thailand's unique consumer behavior and logistics practices.

This study seeks to address this gap by investigating the serial mediating effects of cost on customer satisfaction among online retailers in Thailand. The primary objective of this research is to explore how cost influences customer satisfaction through mediators such as technology usage, product condition, service quality, and transportation time in the context of Thailand's e-commerce logistics. Building on existing literature, the research examines four key factors—services, service technology, transportation time, and product safety—as potential mediators that transmit the influence of cost on customer satisfaction (Oliver and Swan, 1989; Zeithaml, Berry, and Parasuraman, 1993). By classifying these mediators into categories of services, service technology, and outcomes, the study provides a comprehensive framework for understanding how these interrelated factors impact consumer satisfaction (Buhalis and Law, 2008; Fong et al., 2023).

This study presents a significant breakthrough in understanding the complex interplay between cost and customer satisfaction, offering context-specific insights that are particularly relevant to Thailand's e-commerce sector. These findings highlight emerging dynamics within the operations-marketing interface, emphasizing the strategic importance of cost control and technological innovation in enhancing customer satisfaction. By exploring how low-cost strategies influence relationships among services, technology, costs, time, and satisfaction, this study offers valuable insights for online retailers aiming to enhance their competitive edge in the Thai market (Tee, 2022). By addressing these gaps, this study provides actionable insights that are directly applicable to Thailand's e-commerce businesses. These insights can guide logistics providers in leveraging advanced technologies and refining operational strategies to meet the evolving demands of Thai consumers. Moreover, the study contributes to the academic field by addressing the previously unexplored serial mediating effects of cost on customer satisfaction, offering a novel perspective that can inform future research in logistics and e-commerce (Zhang and Liu, 2021).

In summary, this study aims to provide a deeper understanding of the mechanisms through which cost influences customer satisfaction in the online retail sector in Thailand. By examining the mediating roles of service quality, technology usage, transportation time, and product condition, the research offers practical insights for businesses and contributes to the broader academic discourse on customer satisfaction and cost management in logistics and e-commerce. By situating the analysis within Thailand's e-commerce sector, this study provides actionable insights that are directly applicable to local businesses while contributing to global discussions on consumer satisfaction in emerging markets.

2. Literature review

Customer satisfaction is a critical component of business success, directly influencing customer retention, brand loyalty, and positive word-of-mouth. The relationship between cost and customer satisfaction is multifaceted and has been the subject of extensive research across various industries. Understanding this relationship is essential for businesses, particularly in competitive markets where price sensitivity is high, and customer expectations are continually evolving.

From both classical economics and behavioral perspectives, cost is recognized as a fundamental factor that influences customer satisfaction. This influence can be direct, where the cost itself affects satisfaction, or indirect, where cost impacts satisfaction through various mediating factors such as service quality, service technology, transportation time, and product safety. In this literature review, these mediating factors are explored in detail to provide a comprehensive

understanding of how businesses can optimize customer satisfaction through strategic cost management.

2.1. Cost and customer satisfaction

The cost-to-satisfaction relationship is foundational in both marketing and economics literature. Numerous studies have consistently demonstrated that cost significantly influences customer satisfaction, particularly in markets where price is a prominent factor in consumer decision-making (Monroe, 2022). A central theme in this research is the negative correlation between price increases and customer satisfaction, which has led to the development of various models aimed at explaining this dynamic (Grewal et al., 2011). One of the key concepts in understanding this relationship is price fairness. Oliver and Swan (1989) proposed that consumers evaluate the fairness of a price by comparing the cost of a product or service to its perceived quality. When prices are perceived as fair, customers tend to feel more satisfied, whereas perceived unfairness often leads to dissatisfaction regardless of quality. Similarly, the "zone of tolerance" model by Zeithaml, Verleye, Hatak, Koller, and Zauner (2020) suggests that consumers have a range of acceptable prices where satisfaction remains stable, but exceeding this range sharply decreases satisfaction.

Recent research highlights the intricate role of cost in directly shaping customer satisfaction within logistics and e-commerce settings. Effective cost management strategies, such as optimizing routes and reducing operational inefficiencies, enhance satisfaction by ensuring competitive pricing while maintaining basic service standards (Lang, 2020; Lebedeva, Poltavskaya, and Gozbenko, 2023). Open innovation frameworks have transformed e-commerce logistics by integrating external and internal knowledge to co-create solutions. Bounded rationality highlights decision-making under limited information, crucial for fast-paced markets like Thai e-commerce (Chesbrough, 2003). Social open innovation, leveraging collective intelligence from stakeholders like customers and delivery partners, has refined logistics operations (Gurzawska, 2020). These frameworks play a pivotal role in shaping mediating factors such as technology usage and product condition by fostering collaborative approaches to enhance transparency and efficiency. For instance, platforms integrating real-time tracking and blockchain systems improve delivery reliability, directly influencing customer satisfaction outcomes. Platforms such as Shopee and Lazada exemplify this through innovations like real-time tracking and AI chatbots, meeting demands for transparency and speed. Recent advancements in open innovation frameworks have revolutionized e-commerce logistics. AI-driven predictive logistics tools have been implemented to optimize delivery routes and minimize operational inefficiencies. Similarly, blockchain-based transparency systems enable secure, real-time tracking of logistics operations, enhancing customer trust and satisfaction. Additionally, IoT-enabled logistics solutions provide real-time monitoring of product conditions, ensuring better quality control throughout the supply chain (Cai et al., 2021; Chesbrough, 2003). The theoretical underpinnings of this study are rooted in innovation diffusion theory and systems theory. Innovation diffusion theory explains how technological advancements, such as AI and blockchain, are adopted within logistics systems, enhancing efficiency and customer satisfaction. Systems theory provides a holistic perspective, emphasizing the interconnections between cost, mediating factors, and satisfaction outcomes. By applying these theories, the study highlights how open innovation and logistics technology collectively shape the dynamics of e-commerce logistics in emerging markets. Globally, open innovation in car-sharing and e-bike services offers insights for advancing Thai logistics (Gawer and Cusumano, 2014). Similarly, cold chain logistics studies have demonstrated that optimizing distribution costs enhances customer satisfaction without sacrificing service quality (Wang et al., 2021). These findings underscore the direct link between cost efficiency and customer satisfaction when managed effectively. Cold chain logistics provide a compelling example of how cost optimization, when

paired with robust service quality, can simultaneously enhance satisfaction and operational efficiency (Wang et al., 2021).

In addition to these theoretical frameworks, empirical studies have explored the direct impact of cost on customer satisfaction across various sectors. For example, in the airline industry, ticket prices are closely scrutinized by consumers, who often compare prices across different airlines before making a purchase decision. Studies have shown that price increases without improved service quality often reduce satisfaction, leading to negative word-of-mouth (Zeithaml et al., 1993). Moreover, the hedonic pricing model, which explains variations in consumer satisfaction using quality perceptions and the cost paid, has been particularly influential in industries where consumer experience is a key determinant of value. According to this model, consumers derive satisfaction not only from the product or service itself but also from the experience of the purchase, including the perceived fairness of the price (Holbrook, Chestnut, Oliva, and Greenleaf, 1984; Hollebeek, Abbasi, Schultz, Ting, and Sigurdsson, 2022). This theory has been extensively applied in the luxury goods market, where the cost is often associated with exclusivity and prestige, contributing positively to customer satisfaction.

Another significant study by Oliver and Swan (1989) introduced the concept of fairness in price as a ratio of the cost-to-quality standard for a good compared to other products in the same category. Their research found that consumers are more likely to accept higher prices when they perceive that the cause of the price increase is beyond the control of the seller, such as external economic factors. This insight highlights the importance of transparent pricing strategies in maintaining customer satisfaction, particularly in volatile markets.

H1. Cost exerts a direct influence on customer satisfaction, reflecting its critical role as a foundational driver within competitive e-commerce markets.

2.2. Mediation in customer satisfaction research

The relationship between cost and customer satisfaction is complex, often mediated by various factors that either amplify or diminish its impact. Recent studies have emphasized the significance of mediators such as service quality, technology usage, transportation time, and product condition in shaping customer satisfaction across different industries. These mediators provide critical insights into how businesses can manage costs effectively while maintaining or enhancing customer satisfaction.

Service quality plays a pivotal role by directly influencing customer perceptions through dimensions like reliability, timeliness, and responsiveness. High-quality service not only enhances perceived value but also mitigates the negative effects of cost increases (Akl and Urgan, 2022). Technology usage has similarly emerged as a vital mediator, with innovations such as AI-driven customer service platforms and real-time tracking systems boosting transparency and operational efficiency, thereby improving customer experiences (Rashid and Rasheed, 2024). Transportation time is another essential mediator, particularly in the logistics sector, where shorter delivery times have been shown to significantly elevate satisfaction levels, especially in time-sensitive industries such as e-commerce (Uvet, 2020). Lastly, product condition serves as a crucial factor in maintaining customer satisfaction, as the physical integrity of goods during transit directly affects customer trust and satisfaction (Do et al., 2023). These mediators highlight the nuanced pathways through which cost influences customer satisfaction, offering businesses actionable strategies for balancing cost management with customer expectations. The following sections delve deeper into the specific roles of each mediator.

2.2.1. Services quality

Services quality plays a pivotal role in mediating the relationship between cost and customer satisfaction. High-quality services can

significantly enhance the perceived value of a product or service, thereby increasing customer satisfaction even when costs are high (Sann, Pimpohnsakun, and Booncharoen, 2024). The critical role of services in this dynamic is supported by extensive research, particularly in industries where service quality is a key determinant of customer satisfaction. Recent studies in the banking sector, for example, have shown that service quality has a profound impact on customer satisfaction and loyalty. In the highly competitive Ghana banking industry, improving service quality has been found to amplify the positive effects of cost on satisfaction, suggesting that investments in service improvements can offset the negative impacts of higher costs (Tee, 2022). This finding underscores the importance of continuous service quality enhancement in maintaining customer satisfaction.

In the broader context of service industries, the dimensions of service quality—tangibility, reliability, responsiveness, assurance, and empathy—have been extensively studied (Halika and Kharisma, 2024). Each of these dimensions contributes to how customers perceive the value of the service they receive. Reliability, defined as the ability to perform the promised service dependably and accurately, is often cited as one of the most important factors in customer satisfaction (Albar, 2024). When a service is reliable, customers are more likely to feel that the cost they incurred was justified, leading to higher satisfaction levels. Empathy, or the ability of service providers to understand and respond to the individual needs of customers, also plays a significant role in customer satisfaction (Fatima, Malik, and Shabbir, 2018). In high-touch industries such as healthcare and hospitality, where personal interactions are frequent, empathy can be a key differentiator. Service providers who demonstrate a deep understanding of their customers' needs and concerns can create a strong emotional connection, leading to higher levels of satisfaction and loyalty.

Another important aspect of service quality is assurance, which refers to the knowledge and courtesy of employees and their ability to convey trust and confidence. This is particularly important in industries where customers are required to trust the service provider with sensitive information, such as in financial services or legal consulting. When customers feel assured that they are in capable hands, their satisfaction with the service increases, even if the cost is relatively high.

H2. Service quality mediates the relationship between cost and customer satisfaction.

2.2.2. Technology usage

Technology usage is increasingly recognized as a vital mediator in the relationship between cost and customer satisfaction. Advances in technology usage, particularly in service delivery platforms like online transportation services, have reshaped customer expectations and satisfaction levels (Buhalis and Law, 2008). For instance, platforms such as Go-Jek have demonstrated that integrating cutting-edge technology into service delivery can significantly enhance customer satisfaction, even when costs are relatively high (Cahyani, Sari, and Afandi, 2022). The deployment of technology usage improves operational efficiency and enhances the customer experience by providing faster, more reliable service. This enhancement in service quality directly translates to higher customer satisfaction, underscoring the importance of technological innovation in modern service industries. Technologies such as artificial intelligence (AI), data analytics, and mobile applications have revolutionized service delivery, enabling companies to personalize their offerings, predict customer needs, and deliver services more efficiently.

AI-powered chatbots, for example, have become a common feature in customer service, providing instant responses to customer inquiries and resolving issues in real-time. This not only enhances customer satisfaction by reducing wait times but also allows companies to manage a higher volume of customer interactions without increasing costs. Similarly, data analytics enables companies to gain insights into customer behavior, allowing them to tailor their services to meet specific needs and preferences. This level of personalization is highly valued by

customers and can lead to greater satisfaction. In addition to existing technologies, recent innovations such as blockchain and IoT have significantly improved logistics transparency and product condition monitoring. Blockchain ensures secure, tamper-proof records of delivery data, addressing concerns about reliability and accountability. Meanwhile, IoT solutions allow real-time tracking of environmental conditions, such as temperature and humidity, during product transit, ensuring optimal quality delivery for sensitive items like pharmaceuticals and perishable goods (Cai et al., 2021; Chesbrough, 2003). Mobile applications have also transformed the way customers interact with businesses. By providing a convenient platform for customers to access services, make purchases, and communicate with service providers, mobile apps significantly contribute to customer satisfaction. This convenience aligns with the modern consumer's demand for quick and easy access to services, making mobile technology an essential tool for enhancing customer satisfaction. In addition to existing technologies, recent innovations such as blockchain and IoT have significantly improved logistics transparency and product condition monitoring. Blockchain ensures secure, tamper-proof records of delivery data, addressing concerns about reliability and accountability. Meanwhile, IoT solutions allow real-time tracking of environmental conditions, such as temperature and humidity, during product transit, ensuring optimal quality delivery for sensitive items like pharmaceuticals and perishable goods (Cai et al., 2021; Chesbrough, 2003).

The impact of technology usage is particularly evident in the transportation sector, where ride-hailing platforms have disrupted traditional taxi services. By leveraging technology usage, companies like Go-Jek have been able to offer more reliable, efficient, and affordable services, leading to higher customer satisfaction. The success of these platforms highlights the importance of integrating technology into service delivery to meet the evolving expectations of customers. In the Thai e-commerce sector, customer satisfaction is strongly influenced by expectations of transparency and speed in logistics services. The adoption of technology such as real-time tracking and AI chatbots addresses these demands, particularly in a market where rapid delivery is becoming a baseline standard (Thanyawatpornkul, 2024). Additionally, the geographical diversity in infrastructure across rural and urban areas presents unique challenges, amplifying the importance of tailored logistics strategies (Li, 2024).

H3. Technology usage mediates the relationship between services and customer satisfaction.

2.2.3. Transportation time

Transportation time is another critical mediator that links cost to customer satisfaction, particularly in logistics and service delivery contexts. Timely delivery is a key determinant of perceived service quality, which in turn influences customer satisfaction. Studies have shown that shorter transportation times can significantly boost customer satisfaction, even in cases where costs are higher (Lebedeva et al., 2023). Efficient transportation not only improves service quality but also enhances customer satisfaction by meeting or exceeding customer expectations regarding delivery speed. In contrast, delays in transportation can lead to dissatisfaction, even if the cost is low, highlighting the importance of optimizing logistics processes (Krishnan, 2022). The ability to deliver products and services quickly is particularly important in industries where time is a critical factor, such as in e-commerce and perishable goods.

For businesses, transportation time is not just a logistical concern but a key element of the overall customer experience. Fast and reliable delivery can differentiate a company from its competitors, particularly in markets where consumers have multiple options to choose from (Basić and Skender, 2017). In the context of e-commerce, where consumers expect fast delivery, even slight delays can negatively impact customer satisfaction and reduce the likelihood of repeat purchases. Moreover, transportation time is closely linked to the concept of last-mile delivery,

which refers to the final step of the delivery process where the product reaches the customer. Last-mile delivery is often the most challenging and expensive part of the logistics process, but it is also the most visible to the customer. As such, optimizing last-mile delivery is critical for enhancing customer satisfaction. Companies that invest in technologies and processes that reduce transportation time, such as route optimization software and real-time tracking systems, are more likely to meet customer expectations and achieve higher satisfaction levels (Durdu and Kaya, 2023). While studies in developed markets often prioritize sustainability and eco-friendly logistics, Thai consumers place higher value on speed and reliability due to infrastructural limitations. For instance, in Turkey, timeliness and order accuracy significantly impact satisfaction, but in Thailand, these are expected baseline standards (Akil and Ungan, 2022).

In addition to impacting satisfaction directly, transportation time also influences other aspects of the customer experience, such as trust and loyalty. When customers receive their orders on time, their trust in the company increases, which can lead to higher levels of loyalty and repeat business. Conversely, late deliveries can erode trust and damage the company's reputation, leading to customer churn.

H4: Transportation time mediates the relationship between service technology and customer satisfaction.

2.2.4. Product condition

Product condition serves as a critical mediator that significantly impacts customer satisfaction, especially in industries where safety is a primary concern, such as transportation and logistics. Ensuring that products are in optimal condition can enhance customer satisfaction, even when costs are elevated (Tryhuba, Hridin, Slavina, Mushenyk, and Dobrovolska, 2020). Research in the online ride-hailing sector indicates that customers are more satisfied when they perceive services to be reliable and safe, which can mitigate the negative effects of higher costs. Therefore, product condition is a vital component in the service delivery process, ensuring that customer expectations are met, and satisfaction is maintained, even under cost pressures. This underscores the importance of maintaining high standards in product conditions to foster customer loyalty and satisfaction. In sectors like transportation, where the physical condition of products directly affects customer satisfaction, upholding high standards in this area is not just a regulatory requirement but also a competitive advantage. Customers are more likely to choose service providers they perceive as ensuring the best product condition, even if the cost is higher. While studies in developed markets often prioritize sustainability and eco-friendly logistics, Thai consumers place higher value on speed and reliability due to infrastructural limitations. For example, in Turkey, timeliness and order accuracy significantly impact satisfaction, but in Thailand, these are expected baseline standards (Akil and Ungan, 2022).

Moreover, product condition is closely tied to risk management in service delivery. Businesses that proactively manage risks and ensure the integrity of their products are more likely to gain the trust and loyalty of their customers (Tryhuba et al., 2019). This is particularly important in industries such as pharmaceuticals, food delivery, and public transportation, where the condition of the product can significantly influence customer satisfaction (Lohinova, 2023). For example, in the pharmaceutical industry, ensuring that products are free from contamination and in perfect condition is crucial for maintaining customer trust and satisfaction. Similarly, in food delivery services, maintaining the integrity of the food during transportation is essential for customer satisfaction. In the online ride-hailing sector, product condition is a major concern, particularly regarding the conduct of drivers and the condition of vehicles (Tsang et al., 2018). Companies that invest in rigorous quality protocols, such as regular vehicle inspections and quality checks, are more likely to achieve higher levels of customer satisfaction. Additionally, using technology, such as in-app features that allow customers to monitor product condition, can further enhance the perception of reliability and boost customer

satisfaction (Koay, Cheah, and Chang, 2022).

Maintaining high standards of product condition is not only crucial for customer satisfaction but also for legal and regulatory compliance. Companies that fail to meet these standards risk legal consequences, which can damage their reputation and lead to financial losses. Therefore, ensuring optimal product condition is essential for both customer satisfaction and long-term business sustainability.

H5: Product condition mediates the relationship between transportation time and customer satisfaction.

This literature review highlights the intricate relationship between cost and customer satisfaction, mediated by factors such as service quality, service technology, transportation time, and product safety. Each of these mediators plays a critical role in shaping the customer experience and ultimately determines the level of satisfaction achieved. As businesses continue to navigate competitive markets, understanding and optimizing these mediating factors will be essential for sustaining customer satisfaction and achieving long-term success. By investing in service quality, leveraging advanced service technology, optimizing transportation time, and ensuring product safety, businesses can enhance customer satisfaction even when faced with cost pressures. These strategies not only improve the customer experience but also contribute to greater customer loyalty and business success in the long term.

The technology acceptance model offers a robust framework for understanding how customers adopt and engage with new technologies in logistics, highlighting factors like perceived usefulness and ease of use (Cai et al., 2021). Meanwhile, the supply chain management framework emphasizes the integration of logistics capabilities, such as service quality and product condition, to enhance overall satisfaction in dynamic markets (Ramkumar, Schoenherr, Wagner, and Jenamani, 2019). These theoretical frameworks provide valuable insights into the mechanisms through which mediators influence customer satisfaction, further reinforcing the importance of a holistic approach in managing logistics and cost-related challenges.

3. Research design

3.1. Sample

The target population for this research comprised online sellers in Thailand, selected due to their significant role in the nation's growing e-commerce sector. Given the importance of these sellers in driving digital commerce, they represent a critical segment of the economy. The total number of online sellers unknown, the sample size was calculated using a formula for an infinite population, ensuring statistical representativeness. The sample was then stratified by region, with equal sizes allocated to each major region of Thailand, ensuring geographic diversity. A multi-stage sampling process was employed. After determining the regional strata, simple random sampling was used within each region to select respondents. To address potential biases arising from regional differences, data collection was conducted across multiple regions to ensure a diverse representation of respondents. Additionally, to mitigate self-selection bias, the survey was distributed through both random sampling and targeted channels, ensuring a balanced demographic profile that aligns with the study's objectives. Data collection occurred in three rounds: the first round yielded 183 completed questionnaires, the second round added 86 more, and the third round produced an additional 47 responses. After three rounds, the final total of 316 completed questionnaires was considered sufficient for analysis, meeting the criteria for statistical validity. This approach ensured a representative sample of Thailand's online sellers, allowing for robust and reliable analysis of the research findings.

3.2. Measurement

In this study, several established scales were employed to measure the key constructs, including cost, customer satisfaction, technology usage, service quality, product condition, and transportation time, with all responses recorded using a 5-point Likert scale. The selection of specific constructs, such as service quality, technology usage, transportation time, and product condition, was based on their established relevance in prior research within e-commerce logistics (e.g., Zeithaml et al., 2020; Chesbrough, 2003). These constructs were chosen for their demonstrated influence on customer satisfaction in contexts where cost management plays a pivotal role. Alternative constructs were considered but omitted due to their limited applicability to the logistical framework of emerging markets like Thailand. Cost was assessed using a 3-item scale adapted from Bolton, Warlop, and Alba (2003), focusing on perceptions of price fairness, while customer satisfaction was measured using the 12-item American Customer Satisfaction Index (ACSI) by Fornell, Johnson, Anderson, Cha, and Bryant (1996), capturing multiple dimensions of satisfaction. Technology usage was evaluated through a 6-item scale adapted from Jeenaboonrueang (2022), emphasizing ease of use, efficiency, and reliability. Service quality was measured using a 3-item scale from Brady and Cronin (2001), focusing on responsiveness, reliability, and empathy, whereas product condition was assessed with a 3-item scale from Grewal et al. (2011), examining product integrity during transit. Lastly, transportation time was measured using a 3-item scale from Mentzer, Flint, and Hult (2001), which evaluates delivery timeliness and reliability.

A pilot study with 30 Thai online sellers was conducted to ensure clarity and cultural relevance of the items in the Thai e-commerce context. Feedback confirmed that the questions were well understood, requiring no major modifications. To ensure both reliability and validity, the scales were systematically validated. Reliability was assessed using Cronbach’s alpha, with all constructs exceeding the recommended threshold of 0.70, demonstrating strong internal consistency. Additionally, Confirmatory Factor Analysis (CFA) was conducted to assess convergent and discriminant validity. Factor loadings for all items exceeded 0.70, indicating strong individual item reliability, while Average Variance Extracted (AVE) values surpassed the recommended threshold of 0.50, confirming construct validity.

3.3. Validity and reliability of the instrument

To assess construct validity, we employed the Fornell and Larcker (1981) criterion to examine convergent validity and conducted CFA, which produced factor loadings above 0.70 and AVE values exceeding 0.50, demonstrating strong convergent validity. Discriminant validity was established using the Fornell-Larcker criterion. This combined approach allowed for a comprehensive examination of the authenticity of the factors, blending theoretical underpinnings with empirical data. The statistical analysis demonstrated a robust fit between the proposed model and the empirical data, with $\chi^2 = 326.695$, $df = 336$, $p\text{-value} = 0.152$, $\chi^2/df = 1.079$, $GFI = 0.913$, $TLI = 0.995$, $CFI = 0.997$, and $RMSEA = 0.018$. These results met Kline (2023) requirements, with χ^2/df below 2, a p -value above 0.050, and fit indices (GFI, TLI, CFI) near or exceeding 0.90, and an RMSEA below 0.05, enhancing the trustworthiness of our model.

Table 1 presents the standardized factor loadings across various constructs, further demonstrating construct validity. The factor loadings ranged from 0.783 to 0.807 for cost, 0.817–0.841 for service quality, 0.833–0.872 for technology usage, 0.900–0.918 for transportation time, 0.819–0.910 for product condition, and 0.790–0.896 for overall customer satisfaction. All items exhibited significant factor loadings (above 0.50) and were statistically significant at $p < 0.001$.

Additionally, the results for AVE exceeded the recommended threshold of 0.50 for all constructs, confirming convergent validity. The composite reliability (CR) scores ranged from 0.85 to 0.987, exceeding

Table 1
Confirmatory factor analysis results of the questions used in the test.

Latent factors/Questions	Factor loading	Construct validity	
		CR	AVE
Cost 1	0.797	0.987	0.724
Cost 2	0.807		
Cost 3	0.783		
Serv 1	0.841		
Serv 2	0.817		
Serv 3	0.833		
Tech 1	0.872		
Tech 2	0.833		
Tech 3	0.847		
Tech 4	0.850		
Tech 5	0.847		
Tech 6	0.842		
Time 1	0.904	0.987	0.724
Time 2	0.918		
Time 3	0.900		
Con 1	0.819		
Con 2	0.91		
Con 3	0.886		
Sat 1	0.821		
Sat 2	0.790		
Sat 3	0.847		
Sat 4	0.847		
Sat 5	0.808		
Sat 6	0.826		
Sat 7	0.884		
Sat 8	0.865		
Sat 9	0.862		
Sat 10	0.896		
Sat 11	0.893		
Sat 12	0.865		

the reliability threshold of 0.7, indicating strong internal consistency. These findings suggest that the constructs effectively captured their theoretical properties within the context of Thai e-commerce logistics.

3.4. Discriminant validity of constructs

The results of our analyses, as detailed in Table 2, confirmed that the constructs used in this study exhibit strong discriminant validity. This means that each construct is empirically distinct from the others, ensuring that they measure unique aspects of the concepts under investigation. Specifically, the square root of the AVE for each construct exceeded the correlations between that construct and any other construct in the model, following the Fornell and Larcker (1981) criteria. For example, the AVE for cost, transportation time, service quality, technology usage, product condition, and customer satisfaction was 0.724, indicating a high level of discriminant validity for each construct. Additionally, all factor loadings for individual items ranged between 0.783 and 0.918 which (as presented in Table 1), further demonstrating that each construct uniquely contributes to the measurement model.

This robust discriminant validity is crucial because it ensures that each construct contributes uniquely to the overall model, providing a clearer and more accurate understanding of the relationships being studied. Without discriminant validity, it would be challenging to confirm whether the observed relationships genuinely reflect theoretical constructs or are simply artifacts of overlapping measurements. By confirming strong discriminant validity, we can confidently state that the constructs in our study are independently contributing to our understanding of how cost, service quality, technology usage, transportation time, product condition, and customer satisfaction are related in the context of Thai e-commerce logistics.

3.5. Data analysis

The collected data were analyzed using the PROCESS macro for

Table 2
Discriminant validity analysis.

Variables	Cost	Serv	Tech	Time	Con	Sat
Cost	(0.824)					
Serv	0.780**	(0.832)				
Tech	0.707**	0.671**	(0.712)			
Time	0.746**	0.771**	0.693**	(0.828)		
Con	0.724**	0.780**	0.521**	0.710**	(0.765)	
Sat	0.670**	0.597**	0.702**	0.608**	0.709**	(0.719)

** indicates significance level at 0.01, values in parentheses represent the square root of AVE. Serv refers service quality, Tech refers technology usage, Time refers transportation time, Con refers production condition, Sat refers customer satisfaction.
Note:

SPSS, a widely recognized tool for mediation and moderation analysis. This method, developed by Hayes (2017), was selected for its robust ability to analyze complex mediation models while providing bootstrapped confidence intervals to ensure reliable results. The data analysis process involved several key steps. First, the data was cleaned and coded to prepare for analysis. Descriptive statistics were generated to provide an overview of the sample characteristics and the distribution of responses. Following this, the PROCESS macro was used to conduct mediation analysis, testing the hypothesized relationships between cost, customer satisfaction, and the mediating variables (service quality, technology usage, transportation time, and product condition).

The tool’s ability to evaluate multiple mediators simultaneously aligns with this study’s objectives, as it offers a clear examination of the indirect pathways through which cost influences customer satisfaction. Multiple regression models were constructed to examine the direct and indirect effects of cost on customer satisfaction. Bootstrapping with 5000 resamples was performed to generate confidence intervals for the mediation effects, enhancing the reliability of the results. The results were then interpreted in the context of the broader research objectives, emphasizing the practical implications for online retail businesses in Thailand.

4. Results

Among the sample units that responded to the questionnaire, 21.5 % were male, and the remaining 78.5 % were female. Respondents were categorized into the following age groups: below 20 years old (18.5 %), 21–40 years old (44.9 %), 41–60 years old (35.4 %), and over 60 years old (1.2 %). In terms of education, the majority of respondents had attained a Bachelor’s degree (77.5 %), followed by those with a graduate-level education (10.2 %), and the rest had completed high school (12.3 %). Regarding marital status, the majority were single (65.6 %), followed by married individuals (29.2 %), and those who were divorced (5.2 %).

The data analysis was conducted on a sample of 316 online sellers across Thailand, focusing on the relationship between cost and customer satisfaction, with service, technology, transportation time, and product condition as mediators. The total effect of cost on customer satisfaction was substantial ($\beta = 0.776, p < 0.001$), indicating that cost is a significant determinant of customer satisfaction in online retail logistics. The model summary showed that 59.2 % of the variance in customer satisfaction could be explained by the cost factor alone ($R^2 = 0.592$).

When assessing the impact of Cost on Sat, it is notable that the path coefficient ($\beta = 0.776$) exceeds 0.20, demonstrating statistical significance ($|t| > 2.58, p < 0.01$). This suggests that cost serves as a robust predictor of customer satisfaction, as the path coefficient significantly exceeds Cohen’s (1992) criterion for a high level of effect (0.260). The large R^2 value further reinforces this relationship, accounting for a considerable portion of the variance in customer satisfaction. However, it is important to consider that the observed path coefficient and R^2 may be inflated due to potential latent factors not accounted for in the model, which could contribute to the strong observed effect.

Further analysis revealed that the direct effect of cost on customer

satisfaction, after accounting for the mediators, was significantly reduced but remained statistically significant ($\beta = 0.172, p = 0.001$) (Table 3). This reduction, representing a decrease of approximately 77.84 % from the total effect, underscores that a substantial portion of the relationship between cost and customer satisfaction is indeed mediated by the identified variables.

Table 3 presents the results of the bootstrapping analysis, detailing the total, direct, and indirect effects. The analysis revealed significant indirect effects through the mediators, with the total indirect effect calculated as Effect = 0.603, SE = 0.070, 95 % CI [0.468, 0.745]. Notably, technology usage and product condition emerged as the most impactful mediators. The indirect effect via technology usage (Effect = 0.214, SE = 0.049, 95 % CI [0.116, 0.312]) and product condition (Effect = 0.193, SE = 0.053, 95 % CI [0.096, 0.304]) underscores their crucial role in mediating the relationship between cost and customer satisfaction. While the mediation effects through service quality and transportation time were positive, their confidence intervals included zero, indicating that these mediation effects were less consistent and potentially less influential in this context.

In evaluating the path coefficient effects, the analysis confirmed that the direct effect of cost on customer satisfaction is significant, thereby supporting Hypothesis 1. Regarding the mediating effects outlined in Hypotheses 2 through 5, this study found that technology usage ($\beta = 0.213$) and product condition ($\beta = 0.193$) were the most significant mediators, thus supporting Hypotheses 3 and 5. However, the results did not show significant mediation effects for service quality and transportation time, leading to the rejection of Hypotheses 2 and 4.

5. Discussion

The first hypothesis (H1), which proposed that cost has a direct effect on customer satisfaction, was supported by the data, with a significant path coefficient ($\beta = 0.776, p < 0.001$). This finding aligns with the extensive body of literature that emphasizes the critical role of cost in

Table 3
The bootstrapping method total effect, direct effect and indirect effect.

Path analysis	Effect	SE	t	95 % CI	
				LL	UL
Total effect					
Cost -> Sat	0.775	0.041	18.902	0.693	0.857
Direct effect					
Cost -> Sat	0.172	0.051	3.372	0.070	0.273
Indirect path					
Total	0.603	0.069	8.739	0.468	0.745
Cost -> Serv -> Sat	0.097	0.060	1.616	−0.018	0.218
Cost -> Tech -> Sat	0.213	0.049	4.346	0.116	0.312
Cost -> Time -> Sat	0.099	0.060	1.650	−0.019	0.215
Cost -> Con -> Sat	0.193	0.053	3.641	0.096	0.304

Note: SE refers to standard error, t refers to t-value, CI refers to Confidence interval, LL refers to lower limit, UL refers to upper limit. Serv refers to service quality, Tech refers technology usage, Time refers transportation time, Con refers production condition, Sat refers customer satisfaction.

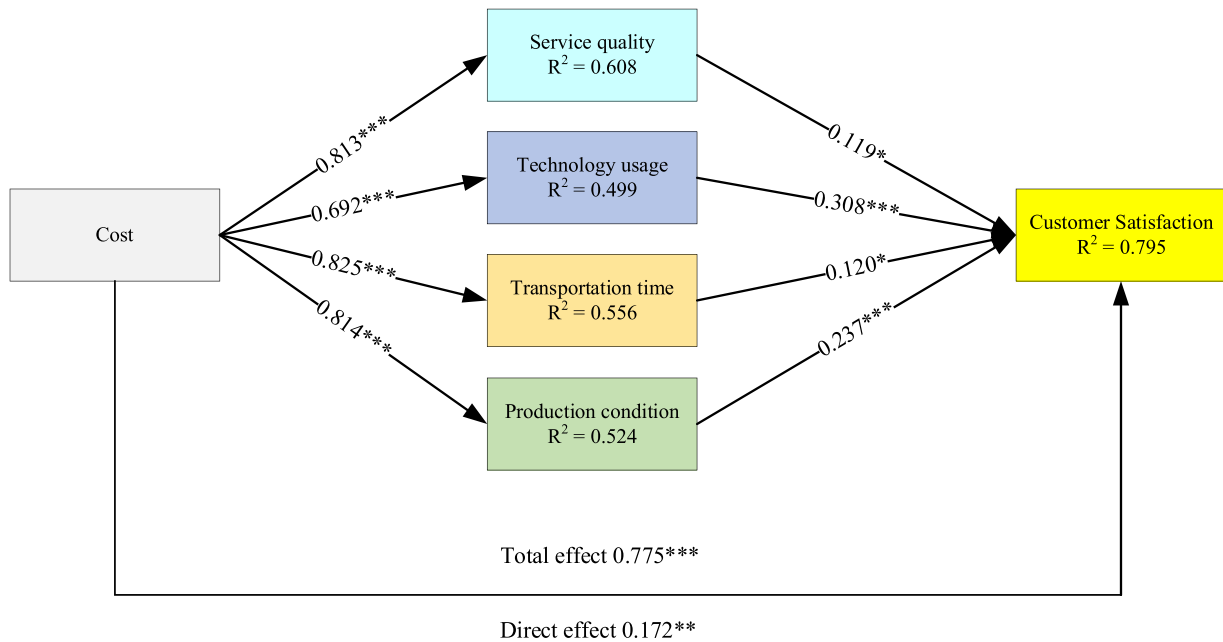


Fig. 1. Analysis of the direct and indirect influence of cost on customer satisfaction through service quality, technology usage, transportation time, and production condition as mediators. Note: *** refers to the significance level at 0.001, ** refers to the significance level at 0.01, * refers to the significance level at 0.05.

shaping customer perceptions and satisfaction levels. According to classical economic theory, cost is a fundamental factor influencing consumer decision-making, with lower costs generally leading to higher perceived value and, consequently, greater satisfaction (Zeithaml et al., 1993). This relationship is particularly salient in the online retail environment, where customers are highly sensitive to price due to the ease of comparing prices across different platforms. Previous research, such as that by Fornell et al. (1996), has also demonstrated that cost is a primary determinant of customer satisfaction, particularly in competitive markets where price sensitivity is high. In the context of online retail logistics, where customers expect both low costs and high service quality, the direct impact of cost on satisfaction underscores the importance for retailers to balance pricing strategies with the delivery of superior service. This balance is crucial for retaining customer loyalty and maintaining a competitive advantage in the market.

The significance of technology usage as a mediator ($\beta = 0.213$) in the relationship between cost and customer satisfaction underscores the pivotal role that technological advancements play in the modern logistics and retail environment. This result aligns with the TAM proposed by Davis (1989), which highlights the importance of perceived usefulness and perceived ease of use in influencing users' acceptance of technology. Real-time tracking systems empower customers with visibility into their orders, reducing uncertainties and fostering trust in the service provider. This visibility is particularly significant in e-commerce, where delays and uncertainties can negatively affect customer satisfaction. In line with open innovation principles, Thai e-commerce platforms such as Shopee leverage crowd-sourced feedback to refine delivery algorithms and product recommendations, co-developing solutions that improve operational transparency and enhance customer satisfaction (Vongurai, 2022). Similarly, AI-driven tools, such as chatbots for instant customer support and predictive analytics for optimizing delivery routes, enhance logistics efficiency and speed. These tools not only address logistical challenges but also improve operational reliability and trust, which are increasingly prioritized in digital markets. These technologies streamline processes, create a more personalized and responsive customer experience, and strengthen transparency and operational reliability—features that are particularly valued by Thai consumers for building trust and long-term satisfaction in the competitive e-commerce market.

In Thailand's e-commerce sector, the adoption of such technologies

aligns with consumer demands for transparency and rapid service, reinforcing their role in driving satisfaction. Recent research highlights that technology-driven services, especially on digital platforms, enhance customer satisfaction by increasing efficiency and adding value to the customer experience (Alwan and Alshurideh, 2022). The ability to track shipments in real-time, receive instant notifications, and interact with customer support through digital platforms are key features contributing to a positive customer experience. E-commerce businesses in Thailand, such as Lazada and Shopee, have successfully leveraged these technologies to improve transparency, reduce logistical inefficiencies, and maintain high service standards in a highly competitive environment.

Moreover, the integration of real-time updates and automated systems by these platforms addresses logistical challenges, reduces perceived risks, and fosters higher levels of trust among consumers. These advancements exemplify how technological tools can meet evolving consumer expectations while enabling businesses to balance cost efficiency with superior service quality.

Similarly, the significant role of product condition as a mediator ($\beta = 0.193$) highlights the critical importance of maintaining product integrity throughout the logistics process. This finding is supported by the Supply Chain Management framework, which emphasizes the need for efficient handling and transportation to ensure that products arrive in optimal condition. Grewal et al. (2011) also highlighted that consumers' perceptions of product safety and integrity are crucial determinants of their overall satisfaction. When customers receive products in excellent condition, their satisfaction with both the product and the service provider increases, reinforcing the importance of product safety in logistics operations. In the Thai context, maintaining high standards of product quality during transit is especially important due to growing consumer concerns about the reliability of online purchases. Companies like Lazada and Shopee, which dominate Thailand's e-commerce sector, have implemented rigorous quality assurance measures, such as protective packaging and enhanced tracking, to meet these expectations. The current study's findings are consistent with research by Mentzer et al. (2001), which demonstrated that the physical condition of products upon arrival is a key component of logistics service quality. Customers associate the condition of the product with the overall reliability and professionalism of the service provider. Therefore, maintaining

exceptional standards in packaging, handling, and transportation is essential for ensuring that products meet or exceed customer expectations, thereby enhancing satisfaction.

While Hypotheses 2 and 4, which proposed service quality and transportation time as mediators, were not supported by the data, these non-significant findings offer valuable insights into the dynamics of Thailand's e-commerce market. The results suggest that service quality and transport time are perceived as baseline expectations rather than differentiators, aligning with findings by Zeithaml et al. (2020), who noted that markets with high levels of service standardization reduce the relative impact of these factors on satisfaction. These non-significant results may reflect the varying levels of acceptance and trust in logistics technologies among Thai consumers. Drawing from the Technology Acceptance Model (TAM), consumers' perceived usefulness and ease of use of logistics technologies, such as real-time tracking systems and AI-driven tools, may overshadow traditional service quality metrics. This suggests that consumers increasingly prioritize features that enhance transparency and operational reliability, rather than incremental improvements in service quality or transport time. Broader adoption and consumer education on logistics technologies could further enhance their perceived value, aligning with TAM's core constructs (Davis, 1989). Thai consumers place significant emphasis on speed and reliability in logistics services, with a growing expectation for transparency through advanced technologies such as real-time tracking systems. However, trust in these technologies can vary, particularly among less tech-savvy demographics. Addressing these trust gaps could provide deeper insights into the dynamics of service quality and transportation time within Thailand's e-commerce context. From the perspective of the TAM, this could indicate that consumers prioritize technological tools—such as real-time tracking systems and AI-driven customer support—that enhance perceived usefulness and ease of use over traditional service quality metrics (Raji et al., 2024). For instance, while consistent transport time remains important, Thai consumers may place greater value on features that provide transparency and reliability, such as shipment tracking and delivery notifications. These findings highlight a shift in consumer expectations within competitive e-commerce markets, where operational innovations increasingly overshadow incremental improvements in service quality.

Additionally, methodological considerations may have influenced these results. For example, the measurement tools used may not have captured subtle variations in service quality (e.g., responsiveness or accuracy of customer support) or transport time (e.g., variations in urban versus rural delivery). Future research should employ more granular measurements to better understand the nuanced roles these factors play in influencing satisfaction.

In conclusion, this study provides a novel perspective on cost as a primary driver of customer satisfaction, mediated by context-specific factors such as technology usage and product condition. Unlike prior research emphasizing service quality and transportation time, the findings reveal emerging dynamics in Thailand's e-commerce logistics, where technological innovation and product integrity are pivotal to sustaining customer trust and loyalty. These findings diverge from existing literature, particularly studies in Western markets, where service quality and transportation time are often considered critical mediators in the cost-satisfaction relationship. In contrast, this study underscores the growing reliance of Thai consumers on technological tools for transparency and the heightened importance placed on product integrity in a rapidly evolving online retail landscape. The prioritization of these factors underscores the context-specific dynamics of consumer behavior in emerging markets like Thailand, where digital adoption and logistics infrastructure continue to advance at a rapid pace. Logistics providers in Thailand could adopt AI-driven tools to optimize delivery routes, predict demand, and enhance customer support. Additionally, IoT-based monitoring systems could be implemented to ensure real-time tracking and monitoring of product conditions, particularly for temperature-sensitive goods like pharmaceuticals and perishables.

These strategies not only enhance operational efficiency but also build consumer trust, addressing key expectations in Thailand's e-commerce market. Furthermore, the findings of this study are not only applicable to Thailand but can also inform practices in other emerging markets with similar e-commerce dynamics, such as Indonesia and Vietnam. These markets share common characteristics, including rapid digital adoption, diverse infrastructure, and growing consumer expectations for transparency and reliability. By leveraging strategies such as AI and IoT adoption, logistics providers in these regions can address operational inefficiencies and enhance customer satisfaction.

These findings emphasize the need for businesses to focus on technological advancements and product safety in logistics operations to enhance customer satisfaction in the online retail sector. Moreover, the integration of these strategies aligns with long-term business goals of sustainability and scalability. By leveraging technology and emphasizing product quality, businesses can not only meet current consumer expectations but also adapt to evolving market demands, ensuring a sustainable competitive advantage in Thailand's dynamic e-commerce sector. Future strategies in the Thai e-commerce market should prioritize operational transparency through technology and maintaining high standards of product safety to address evolving consumer preferences.

6. Theoretical implications

The findings of this study offer several important theoretical implications for the fields of logistics, supply chain management, and customer satisfaction research, particularly within the context of online retail. Firstly, the significant direct effect of cost on customer satisfaction reinforces the enduring relevance of classical economic theory in understanding consumer behavior. This supports the notion that, despite the increasing complexity of modern markets, price remains a fundamental determinant of customer satisfaction. This finding not only validates the core principles of economic theory but also suggests that cost considerations must be integrated into broader models of customer satisfaction, particularly in the online retail environment where price comparison is highly accessible and influential.

Secondly, the study's results highlight the pivotal role of technology as a mediator between cost and customer satisfaction, extending the applicability of the technology acceptance model within the logistics and e-commerce sectors. The significance of technology underscores its transformative impact on customer experiences, suggesting that future theoretical models should place greater emphasis on technological factors when examining customer satisfaction in digitally driven markets. This aligns with the evolving landscape of logistics, where technology not only enhances operational efficiency but also directly influences customer perceptions and satisfaction.

Additionally, the concept of open innovation dynamics provides a complementary lens for understanding the integration of external and internal knowledge in developing logistics solutions. For example, bounded rationality in decision-making and the role of collective intelligence in co-creating service improvements are critical elements that influence customer satisfaction (Cai et al., 2021; Chesbrough, 2003). Future theoretical models should incorporate these dynamics to better capture the complexities of e-commerce logistics, particularly in emerging markets like Thailand.

Furthermore, the significant role of product condition as a mediator aligns with and extends the existing literature on supply chain management. This study reinforces the critical importance of product integrity in logistics services, suggesting that future research should continue to explore the nuances of how product condition affects customer satisfaction across different industries. The findings imply that supply chain management frameworks must account for the end-to-end customer experience, emphasizing the need for rigorous quality control throughout the supply chain.

Finally, the non-significant findings regarding service quality and transportation time as mediators challenge existing assumptions within

the service quality literature. These results suggest that in highly competitive and standardized markets, such as online retail, traditional service quality factors may play a less central role in influencing customer satisfaction. This opens new avenues for research, encouraging scholars to re-examine the relative importance of different service dimensions in contemporary logistics and retail contexts.

7. Practical implications

The results from this study offer critical insights into how logistics and e-commerce businesses can enhance customer satisfaction through strategic focus on technology and product condition. The findings related to Hypotheses 3 and 5, which demonstrated the significant mediating roles of technology and product condition, provide valuable guidance for practitioners seeking to improve service quality and customer experience.

7.1. Technology

The significant mediation effect of technology ($\beta = 0.213$) in Hypothesis 3 underscores the central role that advanced technological solutions play in shaping customer satisfaction. In the context of online retail logistics, where customers increasingly demand transparency, efficiency, and ease of use, investment in technology is not just advantageous but essential. Businesses should prioritize the implementation of real-time tracking systems that allow customers to monitor their deliveries with precision. This technology reduces anxiety and builds trust by providing customers with up-to-date information about their shipments. Additionally, integrating AI-driven customer service tools can streamline customer interactions, resolve issues swiftly, and personalize the service experience. These technological advancements not only meet customer expectations but also create a more seamless and satisfying user experience, leading to higher levels of customer satisfaction and loyalty. For logistics companies, the message is clear: technology should be at the forefront of strategic initiatives aimed at enhancing service quality and customer engagement.

Practices rooted in open innovation, such as leveraging crowd-sourced feedback to improve delivery algorithms and product recommendations, further enhance technological applications in logistics. Thai platforms like Shopee exemplify this approach by integrating consumer-driven insights into their operational models. This not only optimizes technology usage but also fosters stronger customer relationships through participatory innovation practices.

7.2. Product condition

The significant findings for Hypothesis 5 ($\beta = 0.193$) highlight the critical importance of maintaining product integrity throughout the logistics process. The condition in which a product arrives is a direct reflection of the service quality, and any damage or deterioration can severely impact customer satisfaction. To mitigate this risk, businesses should invest in high-quality packaging materials and adopt rigorous handling protocols. Ensuring that products are well-protected during transit not only reduces return rates but also enhances the customer's perception of the brand's reliability and professionalism. Moreover, the use of advanced monitoring systems that track the condition of products in real-time during transportation can further safeguard product integrity, providing an additional layer of quality assurance.

7.3. General practical implications

Beyond the specific findings related to technology and product condition, this study also highlights broader strategic considerations for companies operating in the logistics and e-commerce sectors. First, the results underscore the necessity for an integrated approach to customer satisfaction that considers multiple facets of the customer experience.

While cost remains a significant factor, it is the combination of cost-effective practices with superior service quality, advanced technology, and stringent quality control that truly drives customer satisfaction. Furthermore, as customer expectations continue to evolve in the digital age, companies must remain agile and responsive to these changes. This requires continuous investment in technology not only to meet current demands but also to anticipate future trends. For example, as emerging technologies such as blockchain and IoT become more prevalent in logistics, companies that adopt these innovations early will likely gain a competitive advantage by offering enhanced transparency, security, and efficiency.

Finally, the study suggests that companies should adopt a customer-centric approach in all aspects of their operations. By focusing on what customers value most—reliable service, real-time information, and product integrity—businesses can build stronger relationships with their customers, leading to increased loyalty and long-term success. This holistic focus on customer satisfaction, supported by strategic investments in technology and quality assurance, is crucial for thriving in the increasingly competitive online retail landscape.

8. Limitations and future research

This study, while insightful, has several limitations. First, the research was conducted within the context of online retail logistics in Thailand, which may limit the generalizability of the findings to other regions or industries. For instance, the uneven distribution of infrastructure across urban and rural areas in Thailand significantly influences logistics performance and customer satisfaction. This geographic disparity may not be as pronounced in other countries, particularly those with more developed logistics networks. Moreover, consumer expectations in Thailand may differ significantly from those in more developed markets, where advanced logistics systems and rapid delivery are already normalized. These contextual differences could lead to varying levels of importance placed on mediators such as service quality and transportation time. While the study acknowledges the contextual constraints of Thailand's e-commerce sector, it does not fully address the potential impact of cultural differences on customer satisfaction. For example, trust in logistics technologies and expectations of service quality may vary significantly across cultures. Understanding these nuances is critical for generalizing the findings to other markets. Future research could explore these cultural differences through comparative analyses between emerging and developed markets. Additionally, longitudinal studies could provide valuable insights into how technological advancements and evolving market structures influence customer satisfaction over time. Such studies would allow researchers to capture dynamic changes in consumer behavior and assess the long-term effectiveness of strategies such as AI and IoT adoption in logistics. Additionally, small and medium-sized enterprises (SMEs) in Thailand face financial and technical constraints in adopting advanced logistics technologies, which were not fully explored in this study.

Future research could explore similar hypotheses in diverse geographic and demographic contexts to assess the broader applicability of the findings. Comparative studies between urban and rural regions or between developed and emerging markets may provide additional insights. Longitudinal studies are recommended to examine how relationships between cost, technology, product condition, and customer satisfaction evolve over time. Cross-sector comparisons, such as examining e-commerce logistics versus healthcare or food logistics, may also uncover sector-specific differences.

Emerging technologies such as blockchain, IoT, and AI represent promising avenues for future exploration. These technologies have the potential to revolutionize logistics by improving transparency, reducing costs, and enhancing the overall customer experience.

Future studies should examine the application of open innovation dynamics in cross-industry contexts, such as adapting practices from car-sharing or mobile payment systems to e-commerce logistics.

Additionally, research on managing the limits of open innovation—including balancing openness with strategic control and addressing intellectual property challenges—would provide valuable insights for logistics providers in Thailand and similar markets. Exploring the role of open innovation in SMEs, particularly in integrating low-cost technologies, can also highlight strategies to bridge the gap between small-scale operations and large platforms like Lazada or Shopee. By addressing these areas, future research can continue to provide actionable insights for enhancing customer satisfaction and operational efficiency in the fast-evolving e-commerce logistics sector.

Ethical statement for Thailand science research and innovation

Hereby, I /Khahan Na-Nan/ consciously assure that for the manuscript / Analyzing the Impact of Leader Support on Open Innovation: Exploring the Mediating Role of Organizational Culture, Intellectual Property, and Collaboration in the Thai Food Industry / the following is fulfilled:

“For Human research projects in Behavioral Science, Social Science, and Human Science, approval from the Human Research Ethics Committee is not required.

a research project in which a set of questionnaires, interviews, or observations is not conducted on or affect physical bodies, mentalities, cells, cellular components, genetic materials, specimens, tissues, secretions, health, or behavior, which the individual cannot be directly or indirectly identified.”

1) This material is the authors' own original work, which has not been previously published elsewhere.

2) The paper is not currently being considered for publication elsewhere.

3) The paper reflects the authors' own research and analysis in a truthful and complete manner.

4) The paper properly credits the meaningful contributions of co-authors and co-researchers.

5) The results are appropriately placed in the context of prior and existing research.

6) All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference.

7) All authors have been personally and actively involved in substantial work leading to the paper and will take public responsibility for its content.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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